





# **SUMMARY**

This report provides a detailed explanation of how the OGC APIs work.

It aims to facilitate the implementation of these standards in various organisations.

It is aimed at developers, geospatial data managers and decision-makers in public and private institutions interested in improving interoperability and efficiency in geospatial data management.







# 1. CONTEXT

In a world where geospatial information is increasingly critical to address global challenges, from climate change to natural resource management, interoperability is more important than ever.

Interoperability and the creation of standards are fundamental to the geospatial sector, facilitating collaboration between organisations, driving innovation and ensuring that data is accessible and usable by all. But what do we mean by interoperability and standardisation?

The European Interoperability Framework (EIF) defines interoperability as:

### Interoperability

The ability of disparate and diverse organisations to interact towards mutually beneficial and agreed" common goals, involving the sharing of information and knowledge between the organisations, through the business processes they support, by means of the exchange of data between their respective ICT systems."

Source: European Interoperability Framework (EIF)

Interoperability is, therefore, defined as the ability of different systems, applications and organisations to communicate, exchange data and use that information effectively. In the context of geographic information systems (GIS) and geospatial services, interoperability is crucial because it enables organisations to share and use geospatial data efficiently, improving decision-making and collaboration.

On the other hand, we refer to standards as sets of rules, guidelines or characteristics that ensure that products, services and systems are safe, reliable and work consistently. In the geospatial domain, standards ensure that geospatial data and services are compatible across different platforms and applications. According to the International Organisation for Standardisation (ISO) a standard is defined as:

#### **Standards**

"A document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. The standards are based on the consolidated results of science, technology and experience, and seek to promote interoperability, safety and quality."

Source: International Organisation for Standardisation (ISO)











# What is interoperability? What about standards?

## Interoperability

The ability of different systems, applications and organisations to communicate, exchange data and use that information effectively.

## Standards

Sets of rules, guidelines or characteristics that ensure that products, services and systems are interoperable, secure, reliable and function consistently.

Figure 1: visual summary of the definitions of "interoperability" and "standards"

When it comes to defining standards and working to improve interoperability in the geospatial sector, the work of the Open Geospatial Consortium (OGC) is outstanding.

The Open Geospatial Consortium (OGC) is an international non-profit organisation dedicated to developing and promoting open standards for geospatial data and services. Founded in 1994, the OGC brings together more than 500 members, including government agencies, private companies, academic institutions and international organisations, with the common goal of improving geospatial interoperability.

The OGC promotes the FAIR principles to ensure that geospatial data are:

- Findable: Data must be easy to find for both humans and machines. This implies the use of clear and accessible metadata.
- · Accessible: Data must be accessible through open and well-defined protocols, allowing access and use by different applications and systems.
- Interoperable: Data should be compatible with other data and services, facilitating their integration and joint use through common standards.
- Reusable: Data should be well documented and available in formats that allow for reuse in different contexts and applications.

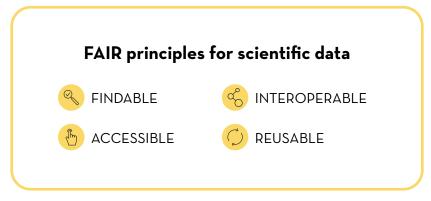


Figure 2: visual summary of the FAIR principles









The main work of the OGC focuses on the creation of standards that facilitate interoperability between different geospatial systems and applications. These standards allow geospatial data and services to be shared and used efficiently and consistently, regardless of the platforms or technologies used.

The main types of spatial standards generated by different bodies can be classified as follows:

#### DATA STANDARDS:

- Geospatial data format: Standards that define how geospatial data is structured. For example, Shapefile, GeoJSON, KML (Keyhole Markup Language).
- Data model: Standards that establish the rules for the representation of geospatial entities and their relationships. For example, CityGML for urban data.
- Metadata schemas: Standards that provide information about geospatial data, including its origin, quality and characteristics. For example, ISO 19115-1.

### SERVICE STANDARDS:

- Geospatial web services: Standards that define how geospatial data and services are published and used over the web. For example, visualisation services (Wep Map Services -WMS- o Web Map Tile Service -WMTS-), download services (Web Feature Service -WFS- o Web Coverage Service -WCS-) or location services (Catalogue Service Web -CSW-). Some of them are also defined by ISO standards.
- Processing services: Standards for the execution of geospatial processes on the web. For example, WPS - Web Processing Service.

### DATA EXCHANGE STANDARDS:

• Data exchange: Standards that facilitate the exchange of geospatial data between different systems and applications. For example, GML - Geography Markup Language as defined in ISO 19136-1:2020.

Interoperability in geospatial services is fundamental to maximise efficiency and collaboration between different systems and organisations, as they allow geospatial data to be accessible in an interoperable way. Spatial standards, and in particular those developed by the OGC, play a crucial role in ensuring that geospatial data and services are compatible and accessible across diverse platforms and applications. These standards enable the integration, exchange and effective use of geospatial information, resulting in better decisions and greater innovation in the geospatial domain.

In this report, we will take an in-depth look at the new OGC standards and look at the concept of Building Blocks, which are modular components designed to facilitate the creation and management of geospatial data and related services. These building blocks provide a standard and reusable framework that allows for efficient integration and operation of location data in various applications and systems. Benefits include interoperability, reusability, efficiency and accuracy in geospatial data management.







# 2. OGC APIS

OGC APIs are resources created by the Open Geospatial Consortium (OGC) to facilitate access to and use of geographic data over the web. An API (Application Programming Interface) allows different programs and applications to communicate with each other and share information in a standardised way. Open data portals have such mechanisms to interact with the information system in a simple way. For those users interested in learning how to publish open data using APIs, we recommend reading this practical guide.

OGC APIs are designed to make geographic data, such as administrative units, place names, parcels, roads, etc., easier to find, access, use and share. These APIs use modern web development technologies (such as REST, JSON, OpenAPI, GeoJSON, CORS and OAuth 2.0) to provide efficient, secure and standardised access to geospatial data and services, making them compatible with a wide variety of applications and platforms. At the same time, they make APIs simple to implement and use, facilitating interoperability and collaboration in the geospatial sector.



## 2.1. ADVANTAGES OF OGC APIS

In the following, we explore the advantages of OGC APIs and how their standards contribute to the interoperability of geospatial services.

- Simplicity and easy to use: OGC APIs are designed to be easy to implement and use. Using REST and JSON, the APIs are easily integrated into modern web applications, allowing developers to access and manipulate geospatial data without the need to learn complex technologies.
- Compatibility and flexibility: Thanks to the adoption of widely accepted standards such as OpenAPI, OGC APIs are compatible with a wide range of technologies and platforms. This allows geospatial data to be used in different applications, from geographic information systems (GIS) to mobile and web applications.
- Interoperability: One of the main objectives of OGC APIs is to facilitate interoperability between different geospatial systems and services. By following common standards, APIs ensure that data can be shared and used consistently across different platforms, which is crucial for cross-organisational collaboration and for the integration of data from different sources.
- · Scalability: OGC APIs are designed to be scalable, which means they can handle large volumes of data and requests without compromising performance. This is particularly important in applications that require rapid access to large geospatial datasets, such as in environmental monitoring or disaster management.
- Safety: The OGC APIs implement security standards such as OAuth 2.0, which allow controlled and secure access to geospatial data. This ensures that only authorised users can access sensitive data, thus protecting the integrity and privacy of the information.
- Innovation and development: By providing a standardised and accessible framework, OGC APIs encourage innovation and the development of new geospatial applications and services. Developers can focus on creating innovative solutions without worrying about data and service compatibility, accelerating the development and delivery of new technologies.







# Benefits of OGC APIs to improve the interoperability of geospatial services

- SIMPLICITY AND EASY TO USE
- INTEROPERABILITY
- COMPATIBILITY AND FLEXIBILITY
- **SCALABILITY**
- INNOVATION AND DEVELOPMENT
- **SAFETY**

Figure 3: visual with the benefits of OGC APIs to improve interoperability of geospatial services

In summary, OGC APIs offer several significant advantages that improve the accessibility, compatibility, security and scalability of geospatial services. By facilitating interoperability, these APIs not only promote collaboration and innovation, but also ensure that geospatial data is used efficiently and effectively in a wide variety of applications.



# 2.2. DIFFERENCES BETWEEN OGC APIS AND WFS/WMS

The development of the OGC APIs started because previous OGC specifications, such as Web Feature Services (WFS), were complex and difficult to use with current web technologies. With the advancement of technology, a simpler and more efficient way of working with geospatial data was needed. To address this, the OGC decided to **update and simplify its standards**, creating the new OGC APIs.

The OGC APIs and the traditional OGC web services for downloading and viewing, WFS and WMS, respectively, are tools designed to access and share geospatial data. However, there are significant differences between them in terms of design, usability and technology.



	OGC APIs	WFS/WMS
Design and Architecture	They use a RESTful architecture, which is lighter and simpler. They use modern data formats based on Open APIs and are designed to integrate easily with modern web applications.	They are based on an older web services architecture, using protocols such as SOAP and XML formats, which can make them more complex and less efficient.
Usability	They offer a more user-friendly development experience, with standardised documentation through OpenAPI. This facilitates its adoption and use by developers with experience in web technologies.	They can be more difficult to implement and use, due to their greater complexity and the need for specific knowledge of XML and other older protocols.
Compatibility	They are highly compatible with modern web technologies and are designed to be flexible and scalable.	Although they are widely used, their compatibility with new technologies may be limited and require additional adaptations.

Figure 4: table comparing the features of OGC APIs and WFS/WMS services

In summary, OGC APIs represent an evolution towards more modern, user-friendly and efficient tools for working with geospatial data, compared to traditional WFS and WMS services.



# 2.3. TYPES OF OGC APIS

The Open Geospatial Consortium (OGC) APIs have revolutionised the way we access and use geospatial data. These application programming interfaces are designed to be more accessible, efficient and compatible with modern web technologies. Below, we explore in detail some of the most important OGC APIs and their features:

## The API Common

The OGC API Common is a standard that contains different components that define the set of common practices and shared requirements that apply to all OGC Web APIs standards. Therefore, this API standard serves as a common foundation on which all other OGC APIs will be built.

### Features:

- It facilitates the integration of geospatial data into web applications.
- It reduces development complexity by using widely adopted standards and technologies.
- It promotes interoperability between different platforms and systems.









**Example of use:** It does not have a specific use case because it is an API that provides common features to the other APIs, so it cannot be used on its own. The following image shows how this API is the basis for the rest, which we will see below.

Utility: This API facilitates communication between different systems and applications, making geospatial data universally accessible and usable.

- Link: https://ogcapi.ogc.org/common/
- Github: <a href="https://github.com/opengeospatial/ogcapi-common">https://github.com/opengeospatial/ogcapi-common</a>

## Components of the OGC Common API and dependency on the other APIs

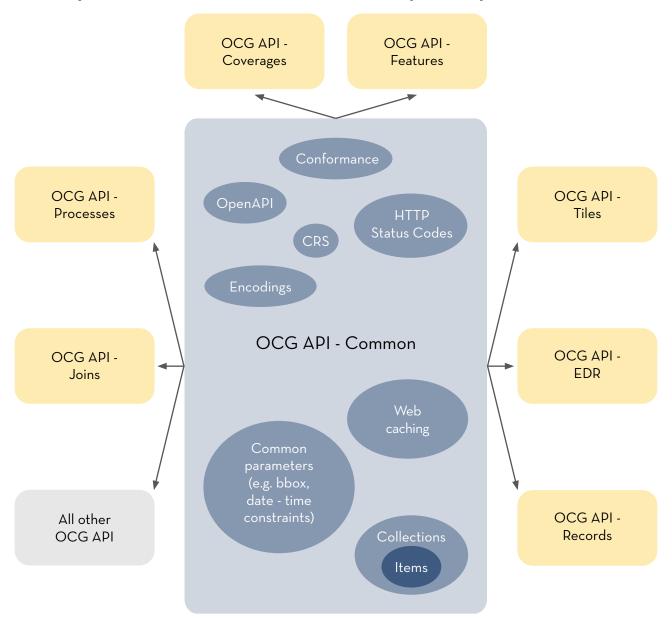


Figure 5: visual with the API Common components and dependency of the other APIs on the API Common







# Geographic Objects API

The OGC API Features is designed to provide access to geographic objects, i.e. vector geospatial data such as points (e.g. portals), curves (e.g. streets) or surfaces (e.g. buildings). This API enables efficient querying, retrieval and manipulation of vector data.



Figure 6: types of geometric objects

### Features:

- It uses REST and JSON for easy integration into web applications.
- It allows queries on specific geographical features.
- It facilitates access to vector geospatial data quickly and efficiently.

Example of use: An urban planning application can use the OGC API Features to access infrastructure data such as <u>railways</u> o <u>buildings</u> and use it for analysis and visualisation.

Utility: The OGC API Features is particularly useful in contexts where detailed analysis of specific geographic features is needed. For example, in infrastructure management, this API can be used to analyse the distribution of road networks, identify areas of congestion and plan new transport routes.

- Link: <a href="https://ogcapi.ogc.org/features">https://ogcapi.ogc.org/features</a>. See an example of addresses <a href="https://ogcapi.ogc.org/features">here</a>.
- Github: https://github.com/opengeospatial/ogcapi-features

# **OGC API Coverages**

The OGC API Coverages is designed to provide access to coverage data<sup>2</sup>, which is geospatial data represented in raster form, such as satellite imagery, orthoimagery, digital elevation models (DEMs), digital terrain models (DTMs) or digital surface models (DSMs).

### Features:

- It enables efficient access to and analysis of raster data.
- It uses modern formats and protocols to ensure compatibility and performance.
- It facilitates access to large coverage datasets for applications such as remote sensing and environmental modelling.









<sup>1.</sup> Geographical object (feature): Abstraction of a real-world phenomenon. [Source ISO 19101-1]. NOTE: "Geographical objects" is synonymous with "Spatial objects".

<sup>2.</sup> Coverage is a geographical object that acts as a function to return values of its range for any direct position within its spatial, temporal or spatio-temporal domain. [Source: ISO 19123:2005, 4.1.7].

Example of use: A climate change researcher can use the OGC API Coverages to access historical satellite imagery and analyse changes in vegetation over time.

Utility: The ability to access coverage data efficiently is crucial for many scientific and monitoring applications. For example, coverage data can be used to analyse the impact of climate change on different ecosystems, monitor deforestation and assess the health of agricultural areas..

- Link: https://ogcapi.ogc.org/coverages
- Github: https://github.com/opengeospatial/ogcapi-coverages

## **OGC API Tiles**

The OGC API Tiles is designed to facilitate access to geospatial information in the form of tiles, a term for smaller subsets of data called tessellations, i.e. pre-rendered map fragments that are assembled to form a complete image. This API is especially useful for applications that require fast and efficient visualisation of geographic products such as land cover or geological maps.

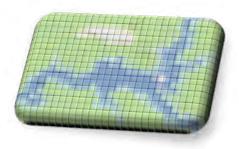


Figure 7: mosaic

### Features:

- It provides standardised access to map tiles.
- It optimises the loading and display of maps in web applications.
- It supports applications that require interactive navigation and detailed map display.

**Example of use:** An interactive map viewer in a mobile application can use the OGC API Tiles to quickly load maps and allow users to navigate and explore different geographic areas.

Utilidad: The OGC API Tiles is essential for applications that require smooth and fast visualisation of maps. This includes navigation applications, real-time geographic information systems and environmental monitoring platforms. By enabling fast loading of map tiles, this API improves the user experience and facilitates geospatial exploration.

- Link: <a href="https://ogcapi.ogc.org/tiles">https://ogcapi.ogc.org/tiles</a>
- Github: https://github.com/opengeospatial/ogcapi-tiles









## OGC Environmental Data Retrieval API (OGC API EDR)

The OGC API Environmental Data Retrieval (EDR) is designed to provide access to environmental data, such as meteorological, air quality and other types of environmental data.

#### Features:

- It facilitates access to real-time environmental data.
- It allows specific queries to be made on different environmental parameters.
- It uses modern standards to ensure compatibility and efficiency.

**Example of use:** A weather forecasting application can use the OGC EDR API to obtain up-to-date weather data and provide accurate, real-time information to users.

Utility: The OGC EDR API is key for applications that rely on real-time environmental data. This includes weather forecasting applications, air quality monitoring and early warning systems for natural disasters. By enabling fast and efficient access to this data, this API improves responsiveness and decision making in critical contexts.

- Link: https://ogcapi.ogc.org/edr
- Github: https://github.com/opengeospatial/ogcapi-environmental-data-retrieval

## **OGC API Joins**

The OGC API Joins is designed to facilitate the joining of different datasets. This API allows data from multiple sources to be combined to obtain more complete and detailed information.

#### Features:

- It allows for spatial joins and combinations of data.
- It facilitates the integration of data from different sources.
- It optimises the geospatial analysis process by combining relevant data.

**Example of use:** A natural resource management organisation can use the OGC API Joins to combine land use, vegetation and water resources data for integrated analysis and informed decision making. Or the connection between statistical data with geospatial data.

Utility: The ability to bring together data from multiple sources is crucial for integrated analysis and to obtain a complete picture of a geographical area. This is especially useful in natural resource management projects, urban planning and environmental studies, where a combination of different types of data is needed to make informed decisions.

- Link: https://ogcapi.ogc.org/joins
- Github: https://github.com/opengeospatial/tjs/

## **OGC API Processes**

The OGC API Processes is designed to run and manage geospatial processes through web services. This API enables geospatial analysis and data transformations in the cloud.











### Features:

- · It allows the execution of complex geospatial analysis processes.
- It facilitates the integration of processing capabilities into web applications.
- It uses modern standards and protocols to ensure compatibility and performance.

Example of use: An environmental monitoring application can use the OGC API Processes to run air quality analysis algorithms and generate detailed reports on pollution in different areas or calculate optimal routes.

**Utility:** The ability to run geospatial processes in the cloud is essential for many modern applications that require complex analysis and data-intensive processing. By enabling the execution of these processes in an efficient and scalable manner, the OGC API Processes facilitates the development of advanced geospatial analysis applications.

- Enlace: https://ogcapi.ogc.org/processes
- Github: <a href="https://github.com/opengeospatial/ogcapi-processes">https://github.com/opengeospatial/ogcapi-processes</a>

OGC APIs represent a significant evolution in the way we work with geospatial data. By using modern technologies, these APIs facilitate the access, use and sharing of geospatial data in an efficient and standardised manner. From querying vector data with the OGC API Features to quickly viewing maps with the OGC API Tiles, each of these APIs offers specific benefits that improve the interoperability and usability of geospatial services.



## 2.4. CURRENT STATUS OF OGC APIS

OGC APIs have undergone significant development in recent years, adopting modern technologies to improve interoperability and efficiency in accessing geospatial data.

The OGC has been organising various events and sprints to validate and improve these APIs. For example, the July 2024 Open Standards Code Sprint and the Joint OGC ASF OSGeo Code Sprint have been important platforms for testing and improving OGC APIs. These events bring together developers and industry experts to collaborate on the implementation and optimisation of OGC standards.

Numerous organisations have implemented the OGC APIs and have received OGC compliance certifications. These certifications ensure that implementations comply with defined standards and can interoperate effectively with other systems using the same APIs. The OGC Validator and other testing resources are available for organisations to validate their implementations and obtain compliance certification.

Despite significant progress, challenges remain in the implementation and adoption of OGC APIs. Some of these challenges include the need to improve documentation and provide more detailed examples of use, to facilitate implementation by developers with different levels of experience. In addition, new capabilities and extensions to existing APIs are being explored, such as support for more complex data models and more advanced queries.

The OGC is also working on new specifications and extensions to existing APIs. For example, new parts of the OGC API Features are being developed that will include capabilities for creating and modifying data, more complex data models and support for richer queries and additional coordinate reference systems.







The current state of OGC APIs reflects significant growth and adoption in the geospatial sector. These APIs have facilitated the integration and efficient use of geospatial data in a wide variety of applications, improving interoperability and accessibility. As the OGC continues to develop and improve these standards, OGC APIs are expected to continue to play a crucial role in the digital transformation of the geospatial sector.



# 2.5. OGC API ROADMAP

The Open Geospatial Consortium has a detailed plan for the development and evolution of its APIs, this roadmap is available to the public on request using the following form. The roadmap of the main OGC APIs is presented below, highlighting current and future developments:

API	Current version	Forthcoming developments
OGC API Features	1.0.1	<ul> <li>Support for additional coordinate reference frames</li> <li>Advanced query and filtering capabilities</li> <li>Creation, modification and deletion of features</li> <li>Improved data models and more complex queries</li> </ul>
OGC API Coverages	1.0.1	<ul> <li>Performance improvements for large volumes of raster data</li> <li>Expanded support for more formats and types of coverage</li> <li>Capacity for more complex queries</li> </ul>
OGC API Tiles	1.0.0	<ul> <li>Support for more types of tesserae and projection systems</li> <li>Real-time loading and display improvements</li> <li>Integration of interactive functions</li> </ul>
OGC API Environmental Data Retrieval (EDR)	1.0.0	<ul> <li>Inclusion of new sources of environmental data</li> <li>Improved temporal query capabilities</li> <li>Expansion of environmental parameters</li> </ul>
OGC API Joins	En desarrollo	<ul> <li>Completion and release of version 1.0.0</li> <li>Advanced tools for data linking</li> <li>Improved efficiency and speed of joining operations</li> </ul>
OGC API Processes	1.0.0	<ul> <li>Inclusion of more types of geospatial processes</li> <li>Optimisation for the processing of large data volumes</li> <li>Integration of machine learning models</li> </ul>

Figura 8. Tabla con la hoja de ruta de las principales OGC API

The OGC APIs roadmap shows a continued commitment to improving and expanding the capabilities of these tools. Future versions and developments promise to offer greater interoperability, performance and functionality, making it even easier to access and use geospatial data in a wide range of applications.





## 2.6. TOOLS FOR IMPLEMENTING OGC APIS

The creation of APIs compatible with Open Geospatial Consortium standards is crucial for the interoperability and efficient exchange of geospatial data. Tools such as GeoServer y pygeoapi provide robust platforms for implementing these APIs.

### 2.6.1 GeoServer

GeoServer is an open-source platform designed to publish, share and edit geospatial data. It is one of the most popular tools for creating APIs compatible with OGC products such as Web Feature Service (WFS) and Web Map Service (WMS). GeoServer allows users to integrate various data formats and reference systems, providing a flexible and scalable framework. To learn more about how to publish an OGC API on Geoserver go to the annex 9.1.

The advantages of using GeoServer to create OGC APIs are:

- · Interoperability: GeoServer enables interoperability between different systems and platforms using OGC open standards. This facilitates the integration of geospatial data into web and desktop applications.
- Scalability: GeoServer is scalable and can handle large volumes of geospatial data. This makes it suitable for applications requiring the processing and visualisation of large datasets.
- Flexibility: GeoServer supports a wide variety of data formats and reference systems, providing a flexible platform for publishing geospatial data.
- Community and support: GeoServer has a large community of users and developers who provide support and resources. This includes extensive documentation, discussion forums and tutorials.

# 2.6.2 pygeoapi

pygeoapi is a Python implementation of the OGC APIs that provides a lightweight and flexible platform for serving geospatial data using modern standards. pygeoapi supports several OGC APIs, such as OGC API Features, OGC API Coverages, and OGC API Processes. To learn more about how to publish an OGC API in pygeoapi go to the annex 9.2.

The advantages of using pygeoapi are:

- · Lightweight and flexible: pygeoapi is lightweight and easy to configure, making it ideal for applications where simplicity and speed of deployment are crucial.
- Compatibility with modern standards: By supporting modern standards such as OGC API Features, pygeoapi facilitates integration with contemporary web applications.
- Integration with other Python libraries: he Python implementation allows seamless integration with other Python projects and libraries, facilitating server customisation and extension.









## 2.6.3 Which tool to choose?

Both GeoServer and pygeoapi offer robust solutions for the creation of OGC compliant APIs:

- **GeoServer** is a mature and widely adopted platform that provides an intuitive graphical interface for publishing geospatial data, ideal for users who prefer a complete, out-of-the-box solution.
- On the other hand, **pygeoapi** offers a lightweight and highly configurable Python-based alternative, ideal for developers looking for flexibility and ease of integration with other software projects.

The choice between GeoServer and pygeoapi will depend on the specific needs of the project, including factors such as the deployment environment, customisation requirements and the team's familiarity with the underlying technologies. Both tools, however, significantly facilitate the creation of geospatial APIs that comply with OGC standards, promoting interoperability and efficient exchange of geospatial data.



# 2.7. VISUALISE DATA PUBLISHED VIA THE OGC APIS IN QGIS

QGIS is one of the most popular and versatile Geographic Information Systems (GIS) used by professionals around the world to analyse and visualise geospatial data. Thanks to its support for a wide range of formats and standards, QGIS can be easily integrated with the Open Geospatial Consortium APIs, allowing users to access and visualise geospatial data directly from web services. In the following, we explain how to visualise an OGC API in QGIS, focusing on the process and advantages of this integration.

Before starting with the integration of an OGC API into QGIS, it is important to make sure that you have the latest version of QGIS installed. In addition, you will need the URL of the OGC API you want to integrate, which is usually provided by the web service hosting the geospatial data.



Advantages of Integrating OGC APIs into QGIS		
Interoperability	OGC APIs are designed to be highly interoperable, which means that they can be easily integrated with various systems and applications. This allows QGIS users to access a wide range of geospatial data without worrying about compatibility issues.	
Access in real time	By using the OGC APIs, geospatial data can be accessed in real time. This is particularly useful for applications that require constantly updated data, such as environmental monitoring or emergency management.	
Flexibility and scalability	OGC APIs allow access to large volumes of data in an efficient manner, which is essential for applications that handle large datasets. In addition, its design based on modern web technologies facilitates scalability.	
Ease of use	The integration of the OGC APIs into QGIS is relatively straightforward and does not require advanced programming skills. Users can add layers of geospatial data using intuitive graphical interfaces, making it easy to access and visualise data.	
Improved decision- making	The ability to visualise and analyse geospatial data in real time significantly improves decision-making. For example, in urban planning, up-to-date data on infrastructure and land use can help to better shape city development.	

Figure 9. Table of advantages of Integrating OGC APIs into QGIS

Visualising OGC APIs data in QGIS (see point 9.3) is a **simple and highly beneficial process** for geospatial professionals. By leveraging the capabilities of QGIS and the interoperability of the OGC APIs, users can access and analyse a vast amount of geospatial data efficiently and in real time. This integration not only improves the accuracy and relevance of geospatial analysis, but also facilitates collaboration and informed decision-making in a variety of applications, from environmental monitoring to infrastructure management.

With the continued development of new capabilities and enhancement of OGC standards, the integration between QGIS and the OGC APIs will continue to provide powerful tools for geospatial data management and visualisation.



# 3. BUILDING BLOCKS

The concept of Building Block in OGC APIs refers to the idea that these APIs are designed as modular and reusable components. Each API focuses on a specific function, such as access to maps, geographic features, data processing or sensors. These building blocks can be combined and used in different configurations to create customised applications to meet specific needs. They have the following characteristics:

- Modularity: The modularity of the OGC APIs allows developers to select and use only the parts of the standard that are relevant to their applications. This results in lighter and more efficient systems, as it is not necessary to implement the full range of functionalities if they are not required.
- Reuse: Modular building blocks can be reused in different projects and configurations, saving time and resources in the development of new geospatial applications. This reusability also makes it easier to upgrade and maintain applications, as individual components can be upgraded without affecting the whole system.
- · Integration: Being based on open standards, OGC's APIs building blocks ensure compatibility and integration with other systems and services that follow the same standards. This facilitates data exchange and collaboration between different platforms and organisations, promoting interoperability in the geospatial domain.
- · Compatibility: OGC standards ensure that geospatial data and services are compatible with each other, allowing applications to use data from multiple sources without integration problems.

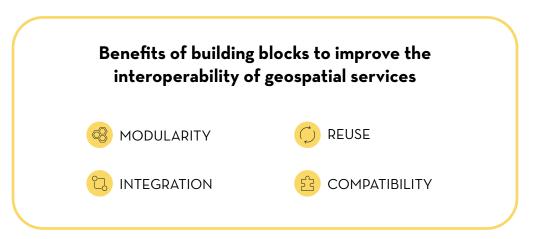


Figure 10: visual with the advantages of building blocks









# 4. CONCLUSIONS

The new standards and the Open Geospatial Consortium (OGC) Building Blocks offer a wide range of benefits that improve the efficiency, interoperability and quality of geospatial applications and services. These benefits extend to developers, organisations and end users, promoting a more integrated and robust geospatial ecosystem.

- Improved interoperability: One of the main advantages of the new OGC standards is improved interoperability between geospatial systems. These standards are designed to facilitate the exchange and integration of data across different platforms and applications, enabling diverse organisations to collaborate more effectively. By ensuring that geospatial data can be shared and used in a uniform way, the ability of institutions to work together on common projects is significantly improved.
- Flexibility and scalability: Modern OGC standards allow developers to create more flexible and scalable applications. The modularity and reusability of components facilitates the adaptation and growth of geospatial solutions as needs grow. This means that applications can be easily adjusted to handle larger volumes of data or to integrate new functionalities, without the need to completely redesign the system.
- Compatibility with modern technologiess: The adoption of modern technologies such as REST, JSON and OpenAPI ensures that the new OGC standards are compatible with current development practices. This improves efficiency and reduces implementation complexity, allowing developers to work with tools and technologies they are already familiar with. Support for modern technologies also facilitates the integration of geospatial data and services into web and mobile applications, extending the reach and utility of this data.
- Development efficiency: The use of common standards and modular components reduces the time and effort needed to develop new applications. By providing clear guidelines and reusable components, OGC standards allow development teams to focus on innovation and continuous improvement, rather than having to reinvent basic solutions each time. This results in faster and more efficient development, with fewer errors and a greater chance of success.
- Access to real-time data: OGC standards facilitate access to real-time geospatial data, which is crucial for applications such as environmental monitoring, emergency management and real-time analysis. The ability to access continuously updated data enables organisations to respond more quickly to events and make informed decisions based on the latest available information.
- Modular and reusable: OGC Building Blocks allow developers to select and use only the parts of the standard that are relevant to their applications, resulting in lighter and more efficient systems. These modular components can be reused in different projects and configurations, saving time and resources in the development of new geospatial applications. Reusability also makes it easier to upgrade and maintain applications, as individual components can be upgraded without affecting the whole system.
- Compatibility and stability: By relying on open standards, Building Blocks ensure the compatibility and stability of applications over time. This is crucial for the long-term maintenance of geospatial systems, as it allows integrating new technologies and upgrading components without causing significant service disruptions. Stability also gives users confidence in the reliability and accuracy of the geospatial solutions they use.











- Ease of integration: OGC Building Blocks facilitate integration with other systems and services, enabling greater interoperability and collaboration between different platforms and organisations. This is especially important in projects that require the combination of data from multiple sources, such as in natural resource management, urban planning and environmental monitoring. The ease of integration also allows organisations to make the most of the data available, creating more complete and useful applications.
- Quality and reliability: OGC standards are developed and maintained through rigorous processes, ensuring high quality and reliability of geospatial data and services. This provides users with confidence in the accuracy and usefulness of geospatial information, which is essential for informed decision-making. Quality and reliability also reduce the risk of errors and problems in geospatial applications, improving the user experience and the bottom line.
- Support: The OGC provides support and maintenance for its standards, ensuring that they remain relevant and up to date with evolving technological and user requirements. This ensures the longevity and continued applicability of the standards over time, providing organisations with a solid foundation on which to build and expand their geospatial solutions.

In **Spain**, the adoption and implementation of OGC APIs is very progressive and although it is constantly growing, some institutions have already adopted this new standard. The National Geographic Institute has been a major adopter of OGC standards, using APIs to publish geospatial data that are crucial for urban planning, environmental monitoring and emergency management. According to the publications collected by the Spatial Data Infrastructure of Spain, according to type of services, in Spain we find these publications:

- · At the national level
  - National Cartographic System (3)
    - https://api-features.idee.es/collections
    - https://api-features.idee.es/
    - <a href="https://api-processes.idee.es/processes">https://api-processes.idee.es/processes</a>
  - · National Geographic Institute (2)
    - https://api-features.ign.es/collections
    - https://api-features.ign.es/
- At regional level
  - · Cartographic and Geological Institute of Catalonia (1)
    - <a href="https://geoserveis.ide.cat/servei/catalunya/inspire/ogc/features/collections/">https://geoserveis.ide.cat/servei/catalunya/inspire/ogc/features/collections/</a>
  - Spatial Data Infrastructure of Navarre IDENA (1)
    - https://idena.navarra.es/ogc/api/

The coming years will see many of today's agencies join the effort to implement OGC APIs as they offer numerous advantages, including improved interoperability, modularity and efficiency in the development of geospatial applications spatial applications.











# 5. WANT TO LEARN MORE?

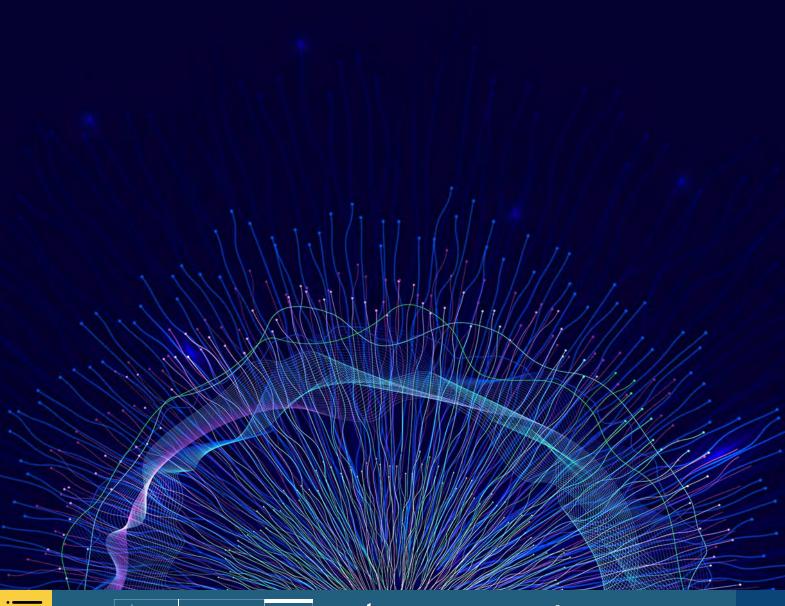
If you want to learn more about OGC APIs, you can take the free OGC Academy course on Service Management. You have to register with the academy first, but the courses are free of charge.



This course provides a comprehensive overview of the OGC APIs standards and how these APIs can be used to facilitate the interoperability of geospatial services. The course includes several real use cases, as well as general and technical descriptions.

## Modules included:

- · Introduction to standards
- · Common aspects of OGC APIs standards
- · Standards for data access
- Other OGC APIs standards.







# 6. ANNEX

The following are the steps and considerations for creating OGC APIs using these GeoServer and geoapi. And it describes how to visualise these services in a desktop GIS such as QGIS:



## 6.1. PUBLICATION OF DATA VIA OGC APIS WITH GEOSERVER

## GeoServer installation

To start working with GeoServer, you need to follow these steps:

### 1. Download and install GeoServer:

- · Visit the website of GeoServer and download the appropriate version for your operating system.
- · Follow the installation instructions provided on the website. GeoServer can be installed on Windows, macOS and Linux.

### 2. Start GeoServer:

• Once installed, start GeoServer from the command line or the operating system shortcut. GeoServer will run as a local web service accessible through a web browser.

#### 3. Access the administration interface:

- Open a web browser and navigate to <a href="http://localhost:8080/geoserver.">http://localhost:8080/geoserver.</a>This is the entry point for GeoServer administration.
- · Log in with the default credentials (user: admin password: geoserver). It is recommended to change these credentials after the first login for security reasons.

# **Publication of Geospatial Data**

Once GeoServer is up and running, you can start publishing geospatial data:

### 1. Add a data warehouse:

- In the administration interface, navigate to "Stores" and select "Add new Store".
- · Choose the type of data store (e.g. Shapefile, PostGIS, GeoTIFF) and provide the necessary information such as file location or database connection details...

### 2. Configure a layer:

- After adding the data in the data warehouse, it is necessary to configure the layers in "Layers" and select "Add new Layer".
- · Select the newly added datastore and choose the layer you want to publish.
- Configure layer details such as rendering style (SLD) and display options.

### 3. Enable OGC services:

- GeoServer allows multiple OGC services to be enabled for each layer. Navigate to "Layer Preview" to verify that the layer has been published correctly.
- Available services include WMS, WMTS, WFS and Web Coverage Service (WCS), among others.









# Configuration of OGC services

To configure specific OGC services, such as OGC API Features, it is necessary to follow the instructions below:

### 1. Add a data warehouse:

- In the administration interface, navigate to "Stores" and select "Add new Store".
- Choose the type of data store (e.g. Shapefile, PostGIS, GeoTIFF) and provide the necessary information such as file location or database connection details.

## 2. Configure a layer:

- After adding a datastore, navigate to "Layers" and select "Add new Layer".
- Select the newly added datastore and choose the layer you want to publish.
- Configure layer details such as rendering style (SLD) and display options.



## 6.2. PUBLISHING DATA VIA OGC APIS WITH PYGEOAPI

# Installation of pygeoapi

To install and configure pygeoapi, follow these steps:

### 1. Install pygeoapi:

· pygeoapi can be installed easily using pip the Python package manager. Run the following command in your terminal:

pip install pygeoapi

## 2. Configure pygeoapi:

· After installation, create a YAML configuration file to define the services and data you want to expose. A basic example configuration is:

```
server:
  url: http://localhost:5000
  name: pygeoapi
  resources:
  example-dataset:
   type: feature
   title: Example Dataset
   description: An example dataset served by pygeoapi
```





# Run pygeoapi

• To start the pygeoapi server, run the following command:

pygeoapi serve

• The server will be available at <a href="http://localhost:5000">http://localhost:5000</a>.

# **Publication of Geospatial Data**

To publish geospatial data, you must follow the steps below:

### 1. Define resources:

- In the configuration file, define the geospatial resources you want to publish. Each resource can be a vector dataset, a raster dataset or a geospatial process.
- For example, for a vector dataset, you should set it up as follows:

```
resources:
  my-vector-data:
   type: feature
   title: My Vector Data
   description: A sample vector dataset
   providers:
   - type: GeoJSON
   data: /path/to/your/data.geojson
```

### 2. Configure services:

- · pygeoapi supports several types of OGC services. In the configuration file, you can enable and configure these services according to your needs.
- For example, to enable OGC API Features:

```
pluguins:
  providers:
  type: feature
  name: OGC API - Features
```











# 6.3. DISPLAYING AN OGC API IN QGIS

### 1. Open QGIS:

· Start QGIS from your computer. If you don't have it installed yet, you can download it from the official QGIS site.

## 2. Add a Vector Layer (OGC API Features):

- Go to the "Layer" menu and select "Add layer" -> "Add vector layer...".
- In the window that appears, select the "Protocol" option and choose "GeoJSON" as the file format. This is because many OGC APIs use GeoJSON to represent vector data.
- Enter the URL of the OGC API Features in the corresponding field. For example, the URL could be something like "https://api.example.com/ogc/features".
- Click "Add" and QGIS will try to connect to the API to load the vector data.

### 3. Add a Raster Layer (OGC API Coverages):

- To add a raster layer from an OGC API Coverages, go to "Layer" -> "Add layer" -> "Add raster layer...".
- In the dialog box, select "Protocol" and choose the supported coverage format, such as WCS (Web Coverage Service).
- Enter the URL of the OGC API Coverages in the URL field. An example URL could be "https://api. example.com/ogc/coverages".
- Click "Add" to load the raster layer into QGIS.

### 4. Adding Map Tiles (OGC API Tiles):

- To add map tiles, go to "Layer" -> "Add layer" -> "Add XYZ layer...".
- In the "XYZ Data Source Manager" window, click on the "+" button to add a new connection.
- Enter a name for the connection and the URL of the OGC API Tiles. The URL could be something like "https://api.example.com/ogc/tiles/{z}/{x}/{y}.png".
- Click "OK" and then "Connect" to load the map tiles into QGIS.

### 5. Access Environmental Data (OGC API EDR):

- To visualise environmental data from an OGC API EDR, use the "WMS/WMTS" plug-in.
- Go to "Layer" -> "Add layer" -> "Add WMS/WMTS layer...".
- In the dialogue window, click on "New" to create a new connection.
- Enter a name for the connection and the URL of the OGC API EDR, e.g. "https://api.example.com/ ogc/edr".
- · Click "OK" and then "Connect" to display the available layers and add them to QGIS.











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